

BEHAVIOURAL BIASES IN BITCOIN TRADING

Taofik Hidajat *)

Abstract

This paper aims to propose some behavioural biases of trading in Bitcoin. It is review literature in the areas of behavioural finance that address issues related to Bitcoin to underpin the conceptual model. A conceptual model for understanding the behavioural bias that affects investing in cryptocurrency is proposed. The biases are herding, optimism, overconfidence, confirmation bias, loss aversion, and gamblers' fallacy. This paper ought to fill the research gap on cryptocurrency from the behavioral perspective. This paper implies that prices and Bitcoin transactions are more determined by psychological factors.

Keywords: *Bitcoin, cryptocurrency, behavioural finance, cognitive bias, emotional bias*

Introduction

Bitcoin, a virtual currency created by Nakamoto (2008), is a new phenomenon that attracts attention. Nakamoto published a research paper on payment instruments in a peer-to-peer manner without the involvement of financial authorities but by open-source software. After Bitcoin, there are many other cryptocurrencies. According to Coincapmarket.com, until the beginning of 2019, there are 2086 cryptocurrencies where Bitcoin dominates the market capitalisation of more than 50%.

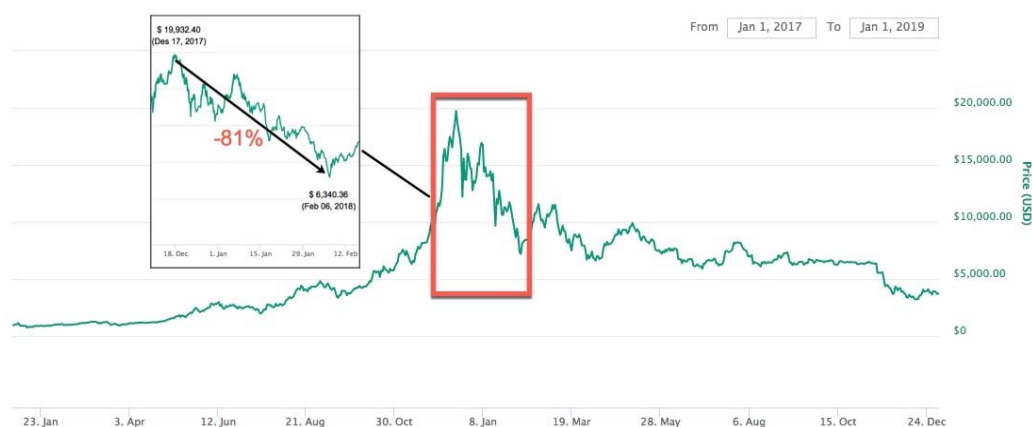
Bitcoin does not have a physical form but is a set of bits generated through open-source software. To be able to get bitcoin stored in an encrypted database called blockchain, miners must be able to decode it. The number of bitcoins in the 21 million blockchains is currently being hunted by miners and becoming a payment tool in the community that accepts bitcoin. Through merchants who are willing to accept payments with bitcoin, this digital currency will then transfer ownership to other parties.

*) *Dosen Sekolah Tinggi Ilmu Ekonomi Bank BPD Jawa Tengah, Semarang, Indonesia*

Basically, from the definition of Bitcoin by Nakamoto, Bitcoin is an alternative currency. However, in reality, Bitcoin and cryptocurrency not only become payment instruments but also become trading instruments. Although the amount of investment and Bitcoin transactions is still less than other assets, the risks to financial and monetary stability can be even higher if the amount increases significantly (Baur, Hong, & Lee, 2017).

The first time Bitcoin launched as a currency occurred on May 22, 2010. A Bitcoin owner pays 10,000 BTC or about \$25 for two pizzas sent to their home. At that time, the value of Bitcoin was around \$0.0025 per coin. Bitcoin prices continue to rise and experience a very significant movement throughout 2017-2018. Cagli (2018) who observed the price movements of Bitcoin and other altcoins shows that there is an explosive behaviour on Bitcoin. Before 2017, the volatility of bitcoin prices was below \$1000. On January 3, 2017, the value of Bitcoin broke through \$1020.47 for the first time in 3 years. But on March 10, 2017, Bitcoin prices rose to \$1201.86 when the US government (SEC) denied Tyler and Cameron Winklevoss operated an exchange-traded fund (ETF) for Bitcoin. On August 1, 2017, the price of Bitcoin was \$2787.85 after the separation of Bitcoin into Bitcoin (BTC) and Bitcoin Cash (BCH). On September 3, 2017, Bitcoin doubled from August prices to \$ 4668.5. At that time, the Chinese government issued an announcement prohibiting new projects from getting funding through cryptocurrency. September 15, 2017, China closed all Bitcoin and Cryptocurrency transactions which caused the price of bitcoin to fall to \$3606.08. October 13, 2017, Bitcoin prices rose again to break through \$5000. October 31, 2017, Bitcoin prices reached \$6,600.84 after CME Group announced plans to open Bitcoin transactions through the futures market. December 11, 2017, CBOE starts trading Bitcoin Futures and triggers a significant increase in the price of Bitcoin to \$14594.78.

Figure 1. Bitcoin Price Chart



Source: <https://coinmarketcap.com> (modified)

On December 17, 2017, the price of bitcoin reached \$ 19,932.40. It was the highest Bitcoin price in the history of Bitcoin prices since 2010 until the end of 2018. Since then, the value of Bitcoin has dropped dramatically. Within about two months, Bitcoin fell more than 80% from \$ 19,932.40 on December 2017 to \$ 6,340.36 on February 2018. The price decrease for two months is faster than the price increase that occurs before the price reaches the highest level. On October 2018, ten years after Nakamoto published his paper, the value of Bitcoin was \$ 6337.06. After that, the price of bitcoin moved with a downtrend until it reached \$ 3,794.46 on January 1, 2019.

Baek & Elbeck (2015) and F. Glaser, Haferkorn, Weber, & Zimmermann (2014) found Bitcoin to be used for speculation. Cheah & Fry (2015) who conducted economic and econometric modelling also found that bitcoin has no fundamental value and has speculative bubbles. Besides being used for speculation, Bitcoin is empirically proven to also not correlate with traditional currencies or assets such as stocks, bonds, commodities (Baur et al., 2017) and gold (Klein, Pham Thu, & Walther, 2018). Carrick (2016) who observed the correlation of Bitcoin with emerging country currencies showed that this cryptocurrency had a negative association with all emerging country currencies, except Chinese Yuan. Ciaian, Rajcaniova and Kancs (2016) also found that economic variables did not have a significant effect on the price of Bitcoin. Theoretically, if bitcoin functions as a currency, it should correlate with a fiat currency such as USD, and if it functions as an investment, it should associate with other assets such as bonds, stocks and commodities. Yelowitz & Wilson (2015) and Foley, Karlsen, & Putniņš (2018) even found that interest in Bitcoin was related to illegal activities. Using search data on Google Trends, Yelowitz and Wilson (2015) found that searches for computer programming and illegal activity were positively related to Bitcoin. Although it is difficult to find evidence about the use of Bitcoin and other cryptocurrencies by terrorist groups, there is strong evidence to suggest that they have been linked to several terror attacks in Europe and Indonesia (Irwin & Milad, 2016).

This phenomenon raises interesting questions about what makes Bitcoin and other cryptocurrencies an instrument that is often transacted and becomes a venue for speculation. According to Kristoufek (2013), the conventional financial theory cannot explain the bitcoin movement. Conventional finance that assumes humans is rational cannot explain how an instrument that has no intrinsic value can have a very high demand and price.

Lehman (2017) states that behavioural perspectives are more appropriate to explain the phenomenon of cryptocurrency. Yang (2018) also argues that the behavioural approach that

emphasises the role of speculators is the answer to explain the anomalies that occur in cryptocurrency. However, most studies on bitcoin and cryptocurrencies focus on bubble dynamics, regulation, cybercriminality, diversification, efficiency (Corbet, Lucey, Urquhart, & Yarovaya, 2018), economic incentive structure, underlying technology and ignoring psychological bias (Antos, 2015). Bitcoin has also not received much attention in the scientific community (Carrick, 2016).

To the best of our knowledge, there is little research on cryptocurrency from the behavioral perspective, namely Ajaz & Kumar (2018), Bouri, Gupta, & Roubaud (2018), Leclair (2018), Poyser (2018), Vidal-Tomás, Ibáñez, & Farinós (2018) who discussed herding and Craggs & Rashid (2016) regarding confirmation bias. This paper ought to fill this gap by discussing cryptocurrency from a behavioural finance perspective. This conceptual paper proposes behavioural bias and illustrates how these biases may influence investors in cryptocurrency, especially Bitcoin.

Method

Cheung, Roca, & Su (2015) stated that Bitcoin is a bubble. Shiller (2000) defined a bubble as "a situation in which news of price increases spurs investor enthusiasm, which spreads by psychological contagion from person to person, in the process amplifying stories that might justify the price increases and bringing in a larger and larger class of investors...despite doubts about the real value of an investment". By using the four bubble stages from Rodrigue (2017), namely Stealth, Awareness, Mania and Blow off phase, this paper tries to make a hypothesis about behavioral bias that exists at each of these stages.

- **Stealth.** The stealth phase is the stage where fewer people who have better access to information are aware of new investment opportunities. Prices begin to move up, but because they do not have strong evidence, the money invested in an asset is still in small amounts.
- **Awareness.** At this stage, prices began to move up, and more investors began to realise the momentum. More and more people are starting to buy and add assets in large quantities. There is a possibility that there will be a slight decline in prices which will benefit people who sell assets when the price drops. However, the fell in prices followed by price increases makes people add to the assets purchased.

- **Mania.** Asset prices rise until they reach the highest level. People see this phenomenon as a lifetime investment opportunity. The media began to play a role by stating that it was a way to create wealth. Logic no longer plays a role because psychological factors more influence it. Humans are becoming increasingly irrational because the rising prices make more money and people come. Greed is everywhere, and everyone tries to enter, especially new investors who don't understand what happened. Conversely, few smart investors who know what's going on quietly begin to withdraw money from the market that is at its peak to take advantage because the bubble will soon erupt.
- **Blow-off.** The stage where everyone who is still in the market sees the price reaching the highest level but after that, it suddenly drops. Some people start selling their assets but the value that rise again makes people feel confident that the price decline is only temporary and prices will rise again. But after a slight increase, the price fell back to the lowest level. Prices drop much faster than when prices rise and return to fair prices. Almost everyone feels cheated but cannot do anything.

Figure 2. Bubble Stages



Source: Rodrigue (2017)

Result and Discussion

Behavioural finance or behavioural economics is one of the mainstream economics aside from conventional economics. Unlike conventional economics or finance which assume that humans are rational, behavioural finance is a combination of psychology and economics that explains why and how people make irrational decisions. Conventional finance assumes that individuals, companies and even markets are rational. They are parties that are considered capable of making an unbiased decision and will try to maximise utility. Expected utility

theory (EUT) states that investors behave rationally by assessing all alternatives by utility and risk.

This rationality is one of the foundations of conventional financial science aside from the mean-variance portfolio theory, capital asset pricing model and market efficiency (Statman, 2008). Rationality is also being an assumption of one of Eugene Fama's financial theories, namely the Efficient Market Hypothesis. Efficient Market Hypothesis states that price movements are random and unpredictable due to the presence of new information which will immediately be reflected in stock prices. In other words, in an efficient market, stock prices reflect all relevant information because rational investors will quickly make adjustments. When an opportunity arises, investors will immediately realise the opportunity by conducting the arbitration. Thus, in an efficient market, investors cannot obtain abnormal returns because the stock market prices already reflect information available on the market. But this rationality was deemed a failure at the fall of the capital market in October 1987. After this event, a new approach emerged that considered the irrationality of investors.

In contrast to Fama and other rationalist economists, Robert Shiller in the early 1990s proposed his ideas about behavioural economics or behavioural finance which denied the assumption of rationality and market efficiency. Some reasons why the efficient market theory cannot be maintained according to Hagstrom (1999) is that investors are not always rational, investors do not process information correctly, and performance measures that emphasise short-term performance cannot beat the market in the long run. Rejection of Efficient Market Hypothesis can be interpreted that the assumption of rational market players and markets is efficient does not apply. Economists have also begun to abandon the assumption that humans behave rationally. McFadden (2013) stated that conventional financial theory has failed to explain how humans make decisions and suggest learning from psychology, anthropology, biology, and neurology.

Shiller's denial of market efficiency was caused by his finding that there was excess volatility in the market. Together with Richard H. Thaler, Shiller developed behavioural finance as a new concept that combines behaviours and psychological aspects in economics and financial decision making that help understand why investors behave in certain ways. According to Baker & Nofsinger (2002), behavioural finance seeks to express the irrationality of investors in general and shows human error in competitive markets. In line with others, Belsky & Gilovich (2010) defines behavioural economics as a combination of psychology and

economics to explain why and how people make irrational or illogical decisions when spending, investing, saving and borrowing money. Thus, the assumption of individuals to behave rationally does not sufficiently occur due to bounded rationality and is the reason for the emergence of behavioural finance.

Behavioural finance is about how people make decisions both individually and collectively which can be distinguished into behavioural finance micro (BMFI) which discusses the behavioural biases of individual investors and behavioural finance macros (BMFA) that explain the anomalies that occur in the efficient market hypothesis (Pompian, 2006). In behavioral finance micro, investor behavior bias according to Baker & Nofsinger (2002) is grouped into how investors think (rules of thumb/heuristics) and how investors feel (emotions), whereas according to Pompian (2006) and Hirschey & Nofsinger (2008) are grouped into cognitive bias (cognitive errors) and emotional bias (emotional error). This behaviour bias affects people in making decisions (Zahera & Bansal, 2018).

Cognitive bias is decision making by using the rule of thumb for information or facts. Cognitive bias according to Baker & Nofsinger (2002) consists of representativeness bias, cognitive dissonance, familiarity bias, mood and optimism, overconfidence, endowment effect, status quo bias, reference points and anchoring, law of small numbers and mental accounting, and according to Pompian (2006) consisted of overconfidence, representativeness, heuristics (anchoring and adjustment), cognitive dissonance, availability, self-attribution bias, illusion of control, conservatism, ambiguity aversion, mental accounting, confirmation bias, hindsight bias, recency bias, and framing bias.

Emotional bias is decision making based on feelings or emotions. Emotional bias describes errors in decision making because it ignores information or facts. The use of feelings as a basis for decision making illustrates an error or bias because it ignores information or facts that should be processed correctly and objectively. Shefrin (2002) stated that investors are influenced by fear and greed in making decisions proves that emotional factors affect how humans think and act. Emotional bias according to Baker & Nofsinger (2002) consists of disposition effect, bias attachment, changing risk preferences, whereas according to Pompian (2006) comprises of endowment bias, self-control bias, optimism, loss of aversion bias, regret aversion bias, and status quo bias.

Based on literature about the cognitive and emotional bias that influenced decision making and that could be applied in cryptocurrency, a conceptual model for understanding

behavioural bias that affects investing in cryptocurrency is proposed. The biases are herding, optimism, overconfidence, confirmation bias, loss aversion and gamblers' fallacy.

Herding

Herding is the tendency of someone who prefers to follow others or imitate group behaviour in making decisions rather than deciding on their own (Baddeley, 2010). The term herding is taken from the concept of animal spirit, which is a group of animals heading in a direction. The behaviour of animals through groups is to avoid the pursuit of predators. Herding is proven to be the most common behavioural bias in the capital market (Kumar & Goyal, 2015) both in developed countries such as US (Hwang & Salmon, 2004) and in developing countries (Agarwal, Chiu, Liu, & Rhee, 2011; Bowe & Domuta, 2004). Herding also occurs in the financial market (Spyrou, 2013).

The study by Ajaz & Kumar (2018) proved the occurrence of herding on cryptocurrency. By using the CSAD method from the six major cryptocurrency and CCI30 market indexes from August 2015 to January 2018, they prove the existence of herding behaviour in the cryptocurrency market. This behaviour depends on the market activity where when the momentum of price increases investors will buy assets, and vice versa. The same research results show that there is herding behaviour in cryptocurrency as evidenced by Bouri et al., (2018), Poyser (2018), and Vidal-Tomás et al., (2018).

Herding on bubbles can occur in the Stealth phase. When few people start hearing about bitcoins whose prices begin to rise, they start buying these assets as investment instruments or even speculation by following other people's behaviour (follow the crowds). Investment in an asset that is not understood but due to following or being affected by another person indicates a trailing behaviour. Public figures through celebrity endorsement are examples that show the influence of other parties in making decisions (Hasanah, 2017).

Complex cryptocurrency technology makes most people do not know what is happening. According to Baur and Dimpfl (2018), there is information asymmetry from cryptocurrency transactions. There is a "fear of missing out" (FOMO) phenomenon in those who don't have much information. The action of others who buy Bitcoin is used as a social proof guide by doing the same thing.

Optimism

Optimism bias is the tendency of someone to overestimate the possibility that positive things will happen and underestimate the potential for unpleasant events (Pompian, 2006). Optimism bias is a belief (which is wrong) that the possibility of someone experiencing a negative event will be lower and the chance of suffering a positive event will be higher than other people. Emotional bias in the form of optimism influences investment decisions. Jacobsen et al. (2014) which examined gender differences in optimism and asset allocation proved that optimism is one of the factors why men prefer stocks over women. Carver, Scheier, & Segerstrom (2010), Bracha & Brown (2012) and Kinari (2016) also showed a relationship between optimism and investment decisions.

In Bitcoin investment, optimism arises after someone sees many people start buying Bitcoin and benefit from rising prices. It will affect emotions in the form of optimism that Bitcoin can give profit. In the bubble stage, this bias occurs in the Awareness phase. People began to realise there was a new instrument that started to attract attention.

Figure 3. Behavioral Biases in Bubble Stages



Overconfidence

Overconfidence is the belief of someone who thinks he/ she knows better and has better information (Pompian, 2006). In the economic literature, overconfidence is often associated with several terms, namely miscalibration, better than average effect, illusion of control, and unrealistic optimism (M Glaser & Weber, 2007). Some research showed that overconfidence has a relationship with investment decisions. For example, Odean (1998), Barber & Odean (2001), Statman, Thorley, & Vorkink (2006), Markus Glaser & Weber (2007), Grinblatt & Keloharju (2009), Abreu & Mendes (2012), Liu & Du (2016), Metawa et al., (2018) and Trepongkaruna et al., (2013) showed that overconfidence affects investment behaviour in capital market and financial market. Someone who is overconfident according to Fischhoff, Slovic, & Lichtenstein (1977) tends to make decisions by weighting excessive valuation on

knowledge and information that is owned and ignoring available public information. According to Barber & Odean (2001), the illusion of control, the illusion of knowledge and self-attribution bias are factors that encourage someone to become overconfident. Pan & Statman (2012) states that one form of overconfident is the belief of someone who can choose stocks that have returns above average. According to Barber & Odean (2001) and Odean (1998), those who are overconfident are shown to do more stock trading transactions.

Overconfidence is very likely related to investments that are risky to Bitcoin. According to Xia, Wang, & Li (2014), overconfidence is associated with risky investment behaviour. This result is consistent with the research of Weber & Camerer (1998) which proved that individuals who are overconfident tend to like risky activities.

In the Mania phase, the price of Bitcoin which reaches the highest level makes investors feel that they have better than average knowledge and abilities. This condition is also influenced by news about Bitcoin in the media. F. Glaser et al. (2014) proved that the volatility of Bitcoin prices is significantly affected by media coverage.

Confirmation bias

Confirmation bias or congruence can occur in the Blow-off phase when prices fall but rise again temporarily. This bias takes the form of a person's tendency to seek information that supports his opinion or overrules information that does not support his belief (Pompian, 2006). Confirmation bias is one cognitive bias that affects not only how people gather information but also influences how to interpret and remember information to fit their opinions or beliefs. People are justifying that the decline in Bitcoin prices is only temporary and will rise again.

Duong, Pescetto, & Santamaria (2014) who researched stock trading listing on the UK stock exchange during 1991-2007 found evidence of confirmation bias on stock investors in responding to good and bad information. Park et al. (2010) who observed the behaviour of 502 investors in South Korea proved that investors experienced confirmation bias when processing information from message boards. This confirmation bias does not only occur in people's behaviour but also in news or information. Nelson (2014) who conducted a study on economic articles found stereotyping, publication bias, and confirmation bias in the economic literature that discussed gender and risk aversion.

In Bitcoin transactions, Ciaian, Rajcaniova and Kancs (2016) finds that new information affects the price movements of Bitcoin. The data source for Bitcoin prices that many traders refer to is Mt. Gox and BTC-e (Brandvold, Molnár, Vagstad, & Andreas Valstad, 2015). More prices are determined by investor confidence about what will happen to the price of Bitcoin shortly. This is why technical analysis is the only approach used to predict the price of Bitcoin.

When the price of Bitcoin starts to go down but reverses a slight increase, investors assume that the price decline is temporary and will again rise. Investors are looking for information and opinions that support their belief that investing in Bitcoin is the right thing. They discard and deny negative opinions about Bitcoin.

Loss aversion

Loss aversion is a bias that can be explained by Prospect Theory. Prospect Theory is used to describe how people make decisions between different choices or prospects, especially in conditions of uncertainty. In Prospect Theory, attitudes toward profits differ from attitudes toward losses where individuals make decisions based on perceived benefits rather than perceived losses. If two choices produce the same thing but one is presented in the profit frame, and the other is presented in the loss frame, then the profit frame will be chosen. Although giving the same results, the emotional impact of suffering a loss is greater than getting a profit. People tend to place losses with more weight than benefits. People tend to focus on how much they lose, not how much they get.

This bias is indicated by the behaviour of being able to survive with an asset in a loss position because it hopes that the situation will turn out to be profitable. People tend not to be able to stand up to profits but instead want to survive against losses. This phenomenon was initially explained by Shefrin & Statman (1985) who observed that most people tend to immediately sell assets that have just provided benefits but can survive not to sell assets that are in a disadvantageous position. According to Rau (2014), loss aversion causes disposition effects whereby investors will retain losing stocks to avoid feeling sorry.

In Bitcoin investment, this bias can occur in the Blow off phase where investors who suffer losses due to price reductions still hold Bitcoin. They feel very suffering if they have to sell Bitcoin in a state of loss.

Gambler's fallacy

According to Hirschey and Nofsinger, gamblers' fallacy is a belief that correction will occur in a fair gamble (negative recency effect). On August 18, 1913, players at the Monte Carlo casino lost a lot of money because (mistakenly) that after so many events (black) in a row, a 'correction' would occur which is the fall of the ball in red. But their estimates missed because the ball still fell in black.

The study by Xu & Harvey (2014) of 565,915 sports bets conducted by 776 online gamblers in 2010 showed that they experienced gamblers' fallacy. In Bitcoin trading, Gamblers' fallacy occurs in the blow-off phase. When prices continue to fall, people think that there will be a price reversal so that it continues to hold bitcoin. But what happened, prices continued to decline until they hit the lowest point.

Conclusion and Suggestion

Conventional economics cannot explain the bubbles that occur in bitcoin and other cryptocurrencies because this phenomenon is related to emotional and cognitive factors. This paper discusses cryptocurrency, especially Bitcoin, from a behavioural finance perspective by proposing the concept of behavioural bias that exists in four bubble stages and can affect investment in Bitcoin.

The behavioural bias that is thought to exist at each stage of the bubble is herding (stealth phase), optimism (awareness phase), overconfidence (mania phase), confirmation bias, loss aversion and gamblers' fallacy (blow off phase). The suggestion for further research is to test behavioural biases at the four bubble stages empirically.

References

- Abreu, M., & Mendes, V. (2012). Information, overconfidence and trading: Do the sources of information matter? *Journal of Economic Psychology*, 33(4), 868–881. <https://doi.org/http://dx.doi.org/10.1016/j.joep.2012.04.003>
- Agarwal, S., Chiu, I., Liu, C., & Rhee, S. G. (2011). The Brokerage Firm Effect in Herding: Evidence from Indonesia. *Journal of Financial Research*, 34(3), 461–479.
- Ajaz, T., & Kumar, A. S. (2018). Herding In Crypto-Currency Markets. *Annals of Financial Economics*, 13(02), 1850006.
- Antos, J. (2015). *Biases in Bitcoin Adoption and Implication for the Future Digital Currency*.
- Baddeley, M. (2010). Herding, social influence and economic decision-making: socio-psychological and neuroscientific analyses. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 365(1538), 281–290.
- Baek, C., & Elbeck, M. (2015). Bitcoins as an investment or speculative vehicle? A first look. *Applied Economics Letters*, 22(1), 30–34.
- Baker, H. K., & Nofsinger, J. R. (2002). Psychological biases of investors. *Financial Services Review*, 11(2), 97–116.
- Barber, B. M., & Odean, T. (2001). Boys will be boys: Gender, overconfidence, and common stock investment. *Quarterly Journal of Economics*, 261–292.
- Baur, D. G., & Dimpfl, T. (2018). Asymmetric volatility in cryptocurrencies. *Economics Letters*, 173, 148–151. <https://doi.org/10.1016/J.ECONLET.2018.10.008>
- Baur, D. G., Hong, K., & Lee, A. D. (2017). Bitcoin: Medium of Exchange or Speculative Assets? *Journal of International Financial Markets, Institutions and Money*. <https://doi.org/10.1016/j.intfin.2017.12.004>
- Belsky, G., & Gilovich, T. (2010). *Why smart people make big money mistakes and how to correct them: Lessons from the life-changing science of behavioral economics*. Simon and Schuster.
- Bouri, E., Gupta, R., & Roubaud, D. (2018). Herding behaviour in cryptocurrencies. *Finance Research Letters*. <https://doi.org/https://doi.org/10.1016/j.frl.2018.07.008>
- Bowe, M., & Domuta, D. (2004). Investor herding during financial crisis: A clinical study of the Jakarta Stock Exchange. *Pacific-Basin Finance Journal*, 12(4), 387–418.
- Bracha, A., & Brown, D. J. (2012). Affective decision making: A theory of optimism bias.

Games and Economic Behavior, 75(1), 67–80.
<https://doi.org/http://dx.doi.org/10.1016/j.geb.2011.11.004>

Brandvold, M., Molnár, P., Vagstad, K., & Andreas Valstad, O. C. (2015). Price discovery on Bitcoin exchanges. *Journal of International Financial Markets, Institutions and Money*, 36, 18–35. <https://doi.org/10.1016/J.INTFIN.2015.02.010>

Cagli, E. C. (2018). Explosive behavior in the prices of Bitcoin and altcoins. *Finance Research Letters*. <https://doi.org/10.1016/J.FRL.2018.09.007>

Carrick, J. (2016). Bitcoin as a Complement to Emerging Market Currencies. *Emerging Markets Finance and Trade*, 52(10), 2321–2334.
<https://doi.org/10.1080/1540496X.2016.1193002>

Carver, C. S., Scheier, M. F., & Segerstrom, S. C. (2010). Optimism. *Clinical Psychology Review*, 30(7), 879–889.

Cheah, E.-T., & Fry, J. (2015). Speculative bubbles in Bitcoin markets? An empirical investigation into the fundamental value of Bitcoin. *Economics Letters*, 130, 32–36. <https://doi.org/10.1016/J.ECONLET.2015.02.029>

Cheung, A., Roca, E., & Su, J.-J. (2015). Crypto-currency bubbles: an application of the Phillips–Shi–Yu (2013) methodology on Mt. Gox bitcoin prices. *Applied Economics*, 47(23), 2348–2358.

Ciaian, P., Rajcaniova, M., & Kancs, d’Artis. (2016). The economics of BitCoin price formation. *Applied Economics*, 48(19), 1799–1815.

Corbet, S., Lucey, B., Urquhart, A., & Yarovaya, L. (2018). Cryptocurrencies as a financial asset: A systematic analysis. *International Review of Financial Analysis*.
<https://doi.org/10.1016/J.IRFA.2018.09.003>

Craggs, B., & Rashid, A. (2016). Poster: The Role of Confirmation Bias in Potentially Undermining Speculative Cryptocurrency Decisions. In *IEEE European Symposium on Security and Privacy*.

Duong, C., Pescetto, G., & Santamaria, D. (2014). How value–glamour investors use financial information: UK evidence of investors’ confirmation bias. *The European Journal of Finance*, 20(6), 524–549. <https://doi.org/10.1080/1351847X.2012.722117>

Fischhoff, B., Slovic, P., & Lichtenstein, S. (1977). Knowing with certainty: The appropriateness of extreme confidence. *Journal of Experimental Psychology: Human Perception and Performance*, 3(4), 552.

Foley, S., Karlsen, J., & Putniņš, T. J. (2018). Sex, drugs, and bitcoin: How much illegal

activity is financed through cryptocurrencies? *Review of Financial Studies*, Forthcoming. <https://doi.org/https://dx.doi.org/10.2139/ssrn.3102645>

Glaser, F., Haferkorn, M., Weber, M., & Zimmermann, K. (2014). How to price a digital currency? empirical insights on the influence of media coverage on the bitcoin bubble.

Glaser, M., & Weber, M. (2007). Overconfidence and trading volume. . *The Geneva Risk and Insurance Review*, 32(1), 1–36.

Glaser, Markus, & Weber, M. (2007). Overconfidence and trading volume. *The Geneva Risk and Insurance Review*, 32(1), 1–36.

Grinblatt, M., & Keloharju, M. (2009). Sensation seeking, overconfidence, and trading activity. *The Journal of Finance*, 64(2), 549–578.

Hagstrom, R. G. (1999). *The Warren Buffett Portfolio: Mastering the Power of the Focus Investment Strategy*. New Jersey: John Wiley & Sons.

Hasanah, K. (2017). PENGARUH CELEBRITY’S ENDORSEMENT DAN WORD OF MOUTH TERHADAP KEPUTUSAN MENONTON FILM NASIONAL. *Fokus Ekonomi*, 12(1), 99–116.

Hirschey, M., & Nofsinger, J. R. (2008). *Investments: analysis and behavior* (Vol. 281). McGraw-Hill Irwin New York, USA.

Hwang, S., & Salmon, M. (2004). Market stress and herding. *Journal of Empirical Finance*, 11(4), 585–616.

Irwin, A. S. M., & Milad, G. (2016). The use of crypto-currencies in funding violent jihad. *Journal of Money Laundering Control*, 19(4), 407–425. <https://doi.org/10.1108/JMLC-01-2016-0003>

Jacobsen, B., Lee, J. B., Marquering, W., & Zhang, C. Y. (2014). Gender differences in optimism and asset allocation. *Journal of Economic Behavior & Organization*, 107, Part(0), 630–651. <https://doi.org/http://dx.doi.org/10.1016/j.jebo.2014.03.007>

Kinari, Y. (2016). Properties of expectation biases: Optimism and overconfidence. *Journal of Behavioral and Experimental Finance*, 10, 32–49. <https://doi.org/http://dx.doi.org/10.1016/j.jbef.2016.02.003>

Klein, T., Pham Thu, H., & Walther, T. (2018). Bitcoin is not the New Gold – A comparison of volatility, correlation, and portfolio performance. *International Review of Financial Analysis*, 59, 105–116.

<https://doi.org/https://doi.org/10.1016/j.irfa.2018.07.010>

- Kristoufek, L. (2013). BitCoin meets Google Trends and Wikipedia: Quantifying the relationship between phenomena of the Internet era. *Scientific Reports*, 3, 3415. Retrieved from <https://doi.org/10.1038/srep03415>
- Kumar, S., & Goyal, N. (2015). Behavioural biases in investment decision making – a systematic literature review. *Qualitative Research in Financial Markets*, 7(1), 88–108. <https://doi.org/doi:10.1108/QRFM-07-2014-0022>
- Leclair, E. M. (2018). Herding in the cryptocurrency market. Retrieved from Researchgate.net
- Lehman, R. (2017). A Behavioral Finance View of Cryptocurrencies. Retrieved from <https://www.behavioralfinance.com/bitcoin-behavior/2017/12/13/a-behavioral-finance-view-of-cryptocurrencies>
- Liu, H., & Du, S. (2016). Can an overconfident insider coexist with a representativeness heuristic insider? *Economic Modelling*, 54, 170–177. <https://doi.org/http://dx.doi.org/10.1016/j.econmod.2015.12.032>
- McFadden, D. L. (2013). *The new science of pleasure*. National Bureau of Economic Research.
- Metawa, N., Hassan, M. K., Metawa, S., & Safa, M. F. (2018). Impact of behavioral factors on investors' financial decisions: case of the Egyptian stock market. *International Journal of Islamic and Middle Eastern Finance and Management*, 12(1), 30–55. <https://doi.org/10.1108/IMEFM-12-2017-0333>
- Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. Retrieved from www.bitcoin.org
- Nelson, J. A. (2014). The power of stereotyping and confirmation bias to overwhelm accurate assessment: the case of economics, gender, and risk aversion. *Journal of Economic Methodology*, 21(3), 211–231. <https://doi.org/10.1080/1350178X.2014.939691>
- Odean, T. (1998). Do investors trade too much? Available at SSRN 94143.
- Pan, C. H., & Statman, M. (2012). Questionnaires of risk tolerance, regret, overconfidence, and other investor propensities. *Journal of Investment Consulting*, 13(1), 54–63.
- Park, J., Konana, P., Gu, B., Kumar, A., & Raghunathan, R. (2010). Confirmation bias, overconfidence, and investment performance: Evidence from stock message boards. *McCombs Research Paper Series No. IROM-07-10*.

- Pompian, M. M. (2006). Behavioral finance and wealth management. *How to Build Optimal Portfolios That Account for Investor Biases*, New Jersey.
- Poyser, O. (2018). Herding behavior in cryptocurrency markets. *ArXiv Preprint ArXiv:1806.11348*. Retrieved from <http://arxiv.org/abs/1806.11348>
- Rau, H. A. (2014). The disposition effect and loss aversion: Do gender differences matter? *Economics Letters*, 123(1), 33–36.
- Rodrigue, J.-P. (2017). *The Geography of Transport Systems*. New York: Routledge.
- Shefrin, H. (2002). *Beyond greed and fear: Understanding behavioral finance and the psychology of investing*. Oxford University Press on Demand.
- Shefrin, H., & Statman, M. (1985). The Disposition to Sell Winners Too Early and Ride Losers Too Long: Theory and Evidence. *The Journal of Finance*, 40(3), 777–790. <https://doi.org/10.1111/j.1540-6261.1985.tb05002.x>
- Shiller, R. J. (2000). *Irrational Exuberance*. Princeton University Press.
- Spyrou, S. (2013). Herding in financial markets: a review of the literature. *Review of Behavioral Finance*, 5(2), 175–194. <https://doi.org/doi:10.1108/RBF-02-2013-0009>
- Statman, M. (2008). *What is behavioral finance?* John Wiley & Sons.
- Statman, M., Thorley, S., & Vorkink, K. (2006). Investor overconfidence and trading volume. *Review of Financial Studies*, 19(4), 1531–1565.
- Trepongkaruna, S., Tant, K., Newby, R., & Durand, R. (2013). Overconfidence, overreaction and personality. *Review of Behavioral Finance*, 5(2), 104–133. <https://doi.org/10.1108/RBF-07-2012-0011>
- Vidal-Tomás, D., Ibáñez, A. M., & Farinós, J. E. (2018). Herding in the cryptocurrency market: CSSD and CSAD approaches. *Finance Research Letters*. <https://doi.org/https://doi.org/10.1016/j.frl.2018.09.008>
- Weber, M., & Camerer, C. F. (1998). The disposition effect in securities trading: An experimental analysis. *Journal of Economic Behavior & Organization*, 33(2), 167–184.
- Xia, T., Wang, Z., & Li, K. (2014). Financial literacy overconfidence and stock market participation. *Social Indicators Research*, 119(3), 1233–1245.

- Xu, J., & Harvey, N. (2014). Carry on winning: The gamblers' fallacy creates hot hand effects in online gambling. *Cognition*, 131(2), 173–180.
<https://doi.org/https://doi.org/10.1016/j.cognition.2014.01.002>
- Yang, H. (2018). Behavioral Anomalies in Cryptocurrency Markets. *SSRN Electronic Journal*. Available at: <https://Ssrn.Com/Abstract=3174421>.
<https://doi.org/https://dx.doi.org/10.2139/ssrn.3174421>
- Yelowitz, A., & Wilson, M. (2015). Characteristics of Bitcoin users: an analysis of Google search data. *Applied Economics Letters*, 22(13), 1030–1036.
- Zahera, S. A., & Bansal, R. (2018). Do investors exhibit behavioral biases in investment decision making? A systematic review. *Qualitative Research in Financial Markets*, 00–00. <https://doi.org/10.1108/QRFM-04-2017-0028>